

## NEW SPECIES OF *ARACHIS* (LEGUMINOSAE) FROM BRAZIL, PARAGUAY AND BOLIVIA

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**Summary:** Valls, J.F.M. & C.E. Simpson. 2005. New species of *Arachis* (Leguminosae) from Brazil, Paraguay and Bolivia. *Bonplandia* 14(1-2): 35-63. ISSN: 0524-0476.

Eleven new species of *Arachis* L. (Leguminosae) are described, representing seven of the nine taxonomic sections of the genus. Eight of the new species were referred to, and classified, in the monograph of Krapovickas and Gregory, but are now treated with their own specific epithet; one species had been collected before 1994, but the material was in sufficient doubt to not be mentioned in the Monograph, and two species were collected after that monograph was submitted for publication. The description of these eleven species will help clarify the systematics of the genus *Arachis*, as well as aid in our understanding of the evolutionary path of certain important materials. Some of these may have played a role in developments which lead to the origin of the cultivated peanut.

**Key words:** *Arachis*, taxonomy, new species, Leguminosae.

**Resumen:** Valls, J.F.M. & C.E. Simpson. 2005. Nuevas especies de *Arachis* (Leguminosae) de Brasil, Paraguay y Bolivia. *Bonplandia* 14(1-2): 35-63. ISSN: 0524-0476.

Se describen once especies nuevas de *Arachis* L. (Leguminosae), que representan siete de las nueve secciones taxonómicas del género. Ocho de las nuevas especies fueron citadas y clasificadas en la monografía de Krapovickas & Gregory, pero son ahora tratadas con su propio epíteto específico; una especie fue recolectada antes de 1994, pero el material dejaba suficientes dudas como para no incluirla en la monografía, y dos especies fueron recolectadas después que la misma fuera sometida a publicación. La descripción de esas once especies ayudará a clarificar la sistemática del género *Arachis*, así como a la comprensión de las líneas evolutivas de ciertos materiales importantes, algunos de los cuales podrían haber tenido un rol en los eventos que llevaron al origen del maní cultivado.

**Palabras clave:** *Arachis*, taxonomía, nuevas especies, Leguminosae.

The monograph by Krapovickas and Gregory adequately covered the historical aspects of the taxonomy of the *Arachis* L. genus and the sixty nine species they described. This addition of eleven species is presented to separate some materials that have been more thoroughly collected and/or researched since the monograph was submitted for publication. Additional studies and more plant material collected have made a difference sufficient to reassign some specimens to a new species and further

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collection efforts in Brazil, Bolivia, and Paraguay have resulted in identification of three totally new materials.

Morphological evaluations, cross-compatibility studies, and some molecular data have aided us in identifying these eleven new species as separate taxa. Our interpretation of the sectional affinities is presented for all of these new species. There are four new species in section *Arachis*; two each in sections *Heterantheae* Krapov. & W.C. Greg. and *Procumbentes* Krapov. & W.C. Greg., and one each in sections *Erectoides* Krapov. & W.C. Greg., *Extranervosae* Krapov. & W.C. Greg. and *Rhizomatosae* Krapov. & W.C. Greg., included in these descriptions.

The three species which were in question in the 1994 monograph but are now more clearly understood are *Arachis submarginata* (aff. *A. Pietrarellii* Krapov. & W.C. Greg. in the monograph), *A. Gregoryi* (aff. *A. Kuhlmannii* Krapov. & W.C. Greg.) and *A. nitida* (treated under *A. glabrata* Benth., but mentioned as somewhat different from the rest of the conspecific materials). The basis of the change of these three species is partially morphological distinction, but also on the cross-compatibility and molecular data.

Five of the new species lacked sufficient data and/or collected material and were not identified in the 1994 monograph as separate species. These are: *Arachis linearifolia* (treated under *A. subcoriacea* Krapov. & W.C. Greg. in the Monograph), *A. Schininii* (under *A. Hoehnei* Krapov. & W.C. Greg.), *A. seridoënsis* [under *A. sylvestris* (A. Chev.) A. Chev.], *A. interrupta* (under *A. pusilla* Benth.) and *A. Pflugeae* (under *A. stenophylla* Krapov. & W.C. Greg.). Two new species have been collected since the Monograph went to press in 1994: *A. Hassleri* and *A. Krapovickasii*.

One last species had been collected in 1983, but was not adequately represented with material for study and the cross-compatibility data were suspect. This accession is now adequately studied, so as to assign it to a new species, *Arachis porphyrocalyx*.

These new species are not incorporated into the keys presented by Krapovickas and Gregory (1994). The revision of the keys will

be subject of a future publication.

The circumscription of each new species derives from the consolidation of inputs from several colleagues, accordingly recognized in the co-authorships below.

### 1. *Arachis porphyrocalyx* Valls & C.E. Simpson *sp. nov.*

Fig. 1

*Arachidi Martii* Handro affinis sed petiolis et rhachidibus setosis differt. Ab *A. villosa* Benth. primo ad aspectu maxime similis, calyce porphyreo, floribus valde minoribus ad basim ramis lateralibus condensatis distinguenda.

*Holotypus hic designatus: BRASIL. Minas Gerais:* Mun. Uberaba, Jardim do Uberaba Country Club, na beira da rodovia BR-050, próximo ao rio Grande, 20 km a sudeste de Uberaba, local modificado com gramado de *Paspalum notatum*, solo argiloso vermelho-escuro muito estruturado, suave-ondulado, 19°58'S, 47°47'W, 490 m, 3-VI-1992, J.F.M. Valls, C.E. Simpson, R.N. Pittman, D.E. Williams & G.P. Silva 13271 (CEN). *Isotypi:* BHCN, BRIT, CTES, G, HUFU, K, MO, NY, P, RB, SP, TEX, US.

Perennial. Thickened secondary roots. Mainstem short, hairy, 5-15 cm long, and procumbent lateral branches. Leaves tetrafoliolate. Leaflets hairy on epiphyll, with marginal bristles; hypophyll showing well marked veins, hairy along the mid-vein and edges. Petiole and rachis with hairs and bristles. Stipules on mainstem 3-11 mm long on the adnate part, 6-22 mm long on the free part, 1-3 mm wide, showing 2-5 veins. Petioles 6-30 mm long, rachis 2-7 mm. Apical leaflets 14-28 x 7-16 mm; basal leaflets 9-23 x 6-13 mm. Internodes 2-28 mm long. Lateral branches hairy, 9 to 36 cm long. Stipules 3-9 mm long in the adnate part, 7-18 mm long in the free part, 1-2 mm wide, showing 2-5 veins. Petioles 8-26 mm long, rachis 2-7 mm. Apical leaflets 11-27 x 9-14 mm; basal leaflets 10-22 x 6-17 mm. Internodes 7-41 mm long, purplish. Hypanthium 2.2-5.7 cm long, villous, pink. Calyx purple, bilabiate,

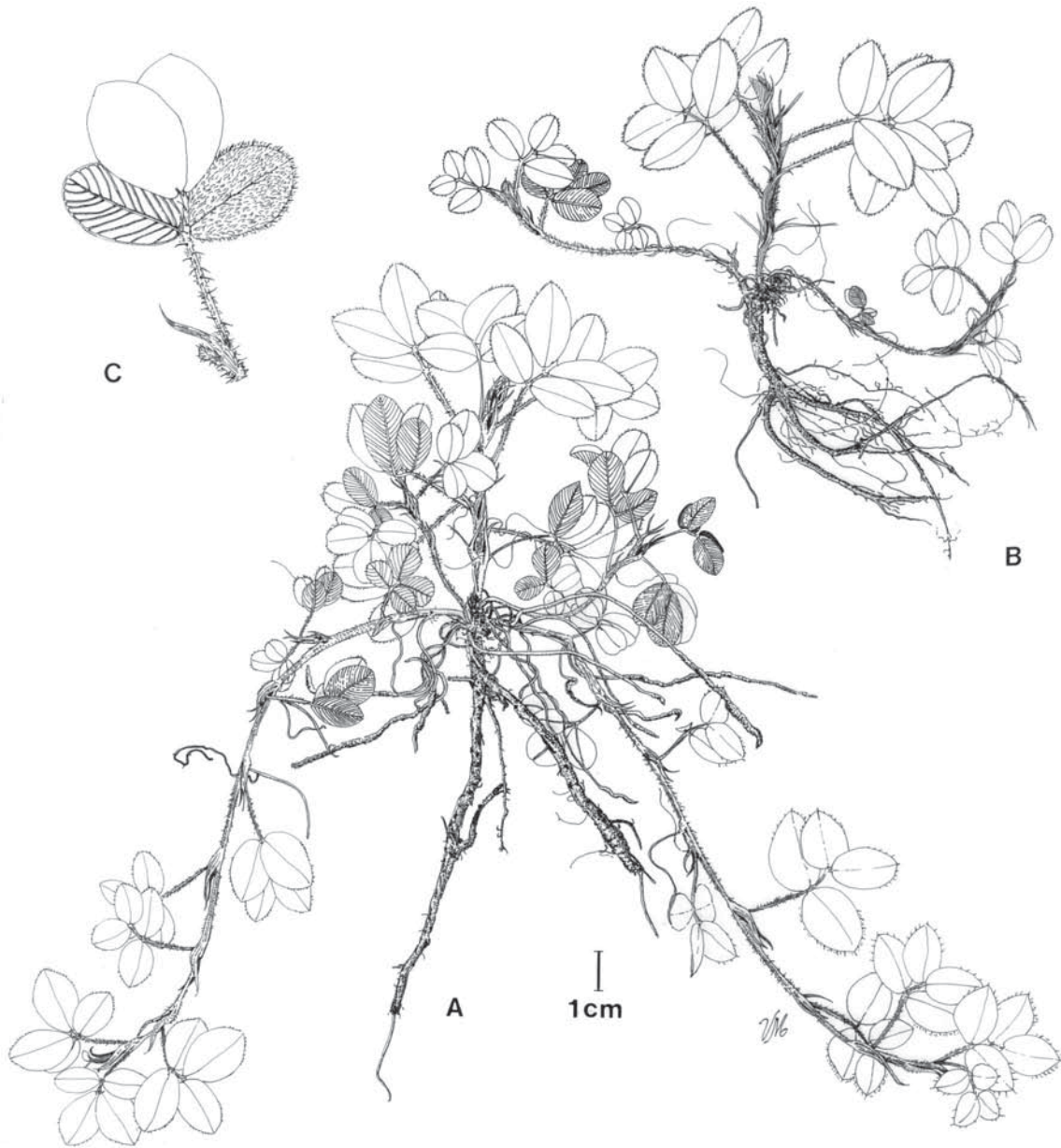


Fig. 1. *Arachis porphyrocalyx*. A: adult plant, showing pegs concentrated at base of lateral branches and thickened secondary roots. B: seedling. C: leaf, showing bristles on petiole and rachis, and both surfaces of leaflets (Valls 7303).

with hairs and bristles, upper lip tetradentate, 4-5 mm long, lower lip falcate, 5-6 mm long. Standard petal orange, with purplish-orange lines and yellow throat, 8-10 mm high x 12-14 mm wide; wings orange with yellow tip. Pegs purplish in the aerial part. Fruit segments usually with distinct but not attenuated beak.  $2n=18$  (Peñaloza & Valls, 2005).

*Paratypus*: **BRASIL. Minas Gerais**: Mun. Uberaba, jardim do Uberaba Country Club, na beira da rodovia BR-050, próximo ao rio Grande, 19°58'S, 47°47'W, 490 m, 11-V-1983, *Valls & al.* 7303 (CEN, CTES).

**Geographic distribution**: Only known from the type location, where it occurs as a voluntary weed in a bahiagrass lawn (*Paspalum notatum* Fluegge), also invaded by *Arachis glabrata*. Presence in a lawn vegetatively established using grass plates transported from elsewhere makes the location of the natural site of occurrence uncertain, but most likely it is somewhere along the nearby border of the Brazilian States of Minas Gerais and São Paulo, south of Uberaba.

**Obs. 1.** Above ground growth resembles *Arachis villosa*, from which *A. porphyrocalyx* is distinguished by the purple calyx, purple coloration in leaves, stems and petioles, smaller flowers, those mostly concentrated at the base of the lateral branches and by the smaller plant growth in mature plants. Purple coloration of plants is not apparent in dried specimen.

**Obs. 2.** The concentration of flowers at the base of the plant and the thickened secondary roots suggest the inclusion of *Arachis porphyrocalyx* in section *Erectoides*. The new species can be morphologically discriminated from others with thickened secondary roots in that section by the procumbent growth habit. Its closest morphological association seems to be with *A. Martii*, which has smaller leaflets and no bristles on the petiole and rachis.

**Obs. 3.** Attempted crosses with *Arachis hypogaea* L. (Tamnut 74) have yielded pegs

and fruits (Simpson, C.E., unpublished) but with aborted embryos only. Other attempted crosses with section *Arachis* materials also failed.

The specific epithet refers to the dark purple to purplish calyx, a strong diagnostic feature to exclude this species from section *Arachis*.

## **2. *Arachis submarginata* Valls, Krapov. & C.E. Simpson *sp. nov.***

Fig. 2

*Ab Arachide Pietrarellii* Krapov. & W.C. Greg., *A. Burchellii* Krapov. & W.C. Greg. et *A. prostrata* Benth., quibus maxime affinis, foliolis in pagina inferiore valde marginatis distinguenda.

*Holotypus hic designatus*: **BRASIL. Mato Grosso**: Mun. Água Boa, BR-158, Água Boa-Ribeirão Cascalheira, 5.4 km ao norte do entroncamento para Cocalinho e do posto Rei da Estrada, cerrado, solo laterítico, suave-ondulado, 13°44'33"S, 52°02'33"W, 330 m, 6-XII-1996, *G.P. Silva & W.L. Werneck 3729* (CEN). *Isotypi*: BM, BRIT, CTES, K, MO, NY, P, RB, SP, UFMT, US.

Perennial herb, with densely hairy, delicate mainstems and lateral branches, and tuberous secondary roots. Mainstems round on fresh specimens, angular in dried herbarium specimens, up to 100 cm; internodes densely hairy, up to 50 mm, only partially covered by the stipules. Mainstem leaves tetrafoliolate, much larger than in the lateral branches, leaflets obovate to broadly elliptic, mostly sparsely hairy on top, pubescent on bottom, especially on veins and margins; leaflet bottom strongly marginated; apical pair 9-38 mm long, 8-18 mm wide; basal pair 9-35 mm long; 8-18 mm wide; bristles on leaflet margins but not on surfaces. Petiole 3-38 mm long; rachis 2-18 mm long; both with many long hairs. Hairs of two types: short adpressed and long (to 1.5 mm), but no, or very few, bristles. Stipules on mainstem hairy, mostly on margin, with some specimens having no surface hairs, others with long and scattered

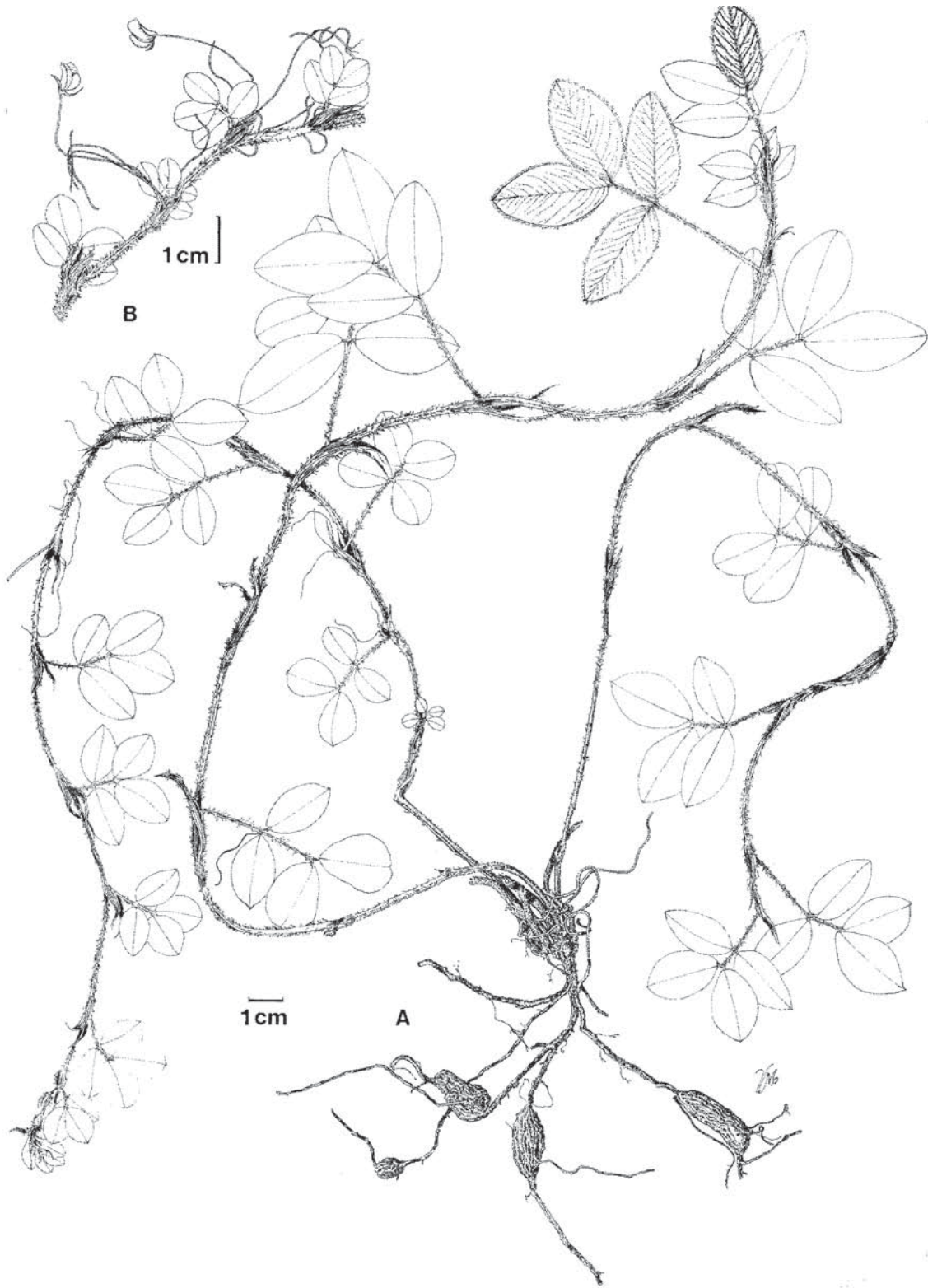


Fig. 2. *Arachis submarginata*. A: adult plant, showing tuberous roots. B: flowering segment of lateral branch (*Silva* 3729).

or short and numerous hairs. Adnate part 4-13 mm long, 2.5-4 mm wide, with 4-9 veins; free part 5-18 mm long, rarely with bristles. Lateral branches rounded when green, angular when dry, procumbent, up to 50 cm long, very sparsely branched, occasionally the initial branch leaves with three leaflets, otherwise tetrafoliolate. Internodes up to 33 mm long, scarcely covered by the stipules. Leaflets broadly elliptic, mostly glabrous on top, pubescent on bottom, especially on veins and margins; leaflet bottom strongly marginated. Apical pair 6-28 mm long and 6-15 mm wide; basal pair 6-26 mm long, 2-15 mm wide, bristles on leaflet margins, but not on surfaces. Petioles hairy, 2-28 mm long, rachis 1-10 mm long, rarely with bristles. Stipules on lateral branches hairy, mostly on margins, with some specimens having no surface hairs, others with long and scattered or short and numerous hairs; adnate part 2-12 mm long, 1.5-3.5 mm wide, with 3-8 veins; free part 6-16 mm long. Hypanthium 2.6-4.8 cm long, with numerous fine hairs up to 1.5 mm. Calyx bilabiate with many hairs, but not bristles. Upper lip tetradentate, lower lip falcate, hairy. Standard petal orange with purple lines on the back, wings yellow; both glabrous. Standard to 8-15 mm wide x 9-12 mm high. Pegs to 8.4 cm long, with many short hairs. Fruits 10 x 6 mm and mostly smooth, with faint veins and beak not apparent.  $2n=20$  (Peñaloza & Valls, 2005).

*Paratypi*: **BRASIL. Mato Grosso**: Mun. Água Boa, 40,8 km ao norte da saída de Água Boa na BR-158, 360 m, 19-VIII-1984, *Valls & al. 7786* (CEN, CTES); id., 14-VI-1990, *Valls & al. 12564* (CEN, CTES); 4,9 km ao norte do entroncamento para Cocalinho e do posto Rei da Estrada, na BR-158, entre Água Boa e Cascalheira, 13°44'34"S, 52°02'32"W, 20-X-2004, *Valls & al. 15039* (CEN); id., plantas recém germinadas, *Valls & al. 15040* (CEN); 700 m ao norte do Auto Posto Rei da Estrada e do início da estrada para Cocalinho na BR-158, 14-VI-1990, *Valls & al. 12568* (CEN, CTES); id., 6-XII-1996, *Silva & Werneck 3728* (CEN); id., 14-IV-1997, *Valls & al. 14099* (CEN); id., 13°46'26"S, 52°02'30"W, 20-X-2004, *Valls & al. 15035* (CEN); 37,5 km ao norte do acesso principal a Água Boa na BR-158, na intersecção para Cocalinho, Auto Posto

Rei da Estrada, 13°46'45"S, 52°02'27"W, 14-VI-1990, *Valls & al. 12567* (CEN, CTES); km 38,1, 320 m, 6-XII-1996, *Silva & Werneck 3725* (CEN, CTES); 27,2 km ao norte da saída de Água Boa na BR-158, 13°49'S, 52°03'W, 330 m, 19-VIII-1984, *Valls & al. 7784* (CEN, CTES); id., 9-VI-1990, *Valls & al. 12517* (CEN, CTES); km 27,1, 13°51'46"S, 52°03'45"W, 5-XII-1996, *Silva & Werneck 3723* (CEN, CTES); 12,1 km ao sul do início da estrada para Cocalinho e 29,6 km ao norte do acesso principal a Água Boa na BR-158, 20-X-2004, *Valls & al. 15041* (CEN); BR-158, Água Boa - Ribeirão Cascalheira, km 26,9, 13°51'51"S, 52°03'51"W, 380 m, 5-XII-1996, *Silva & Werneck 3722* (CEN); BR-158, Água Boa - Ribeirão Cascalheira, km 23,5, 13°53'44"S, 52°04'16"W, 480 m, 6-XII-1996, *Silva & Werneck 3724* (CEN, CTES); id., 10-IV-1997, *Valls & al. 14097* (CEN); id., 20-X-2004, *Valls & al. 15044* (CEN); id., plantas recém germinadas, *Valls & al. 15045* (CEN). Mun. Nova Nazaré, 3,3 km a leste do Auto Posto Rei da Estrada (na BR-158) na estrada para Cocalinho, 13°47'04"S, 52°00'46"W, 290 m, 15-XII-1996, *Silva & Werneck 3751* (CEN); id., 3,7 km, 20-X-2004, *Valls & al. 15037* (CEN); id., plantas recém germinadas, *Valls & al. 15038* (CEN); id., 24 km, 13°50'42"S, 51°51'44"W, 300 m, 15-XII-1996, *Silva & Werneck 3752* (CEN); id., 17-X-2004, *Valls & al. 15013* (CEN); id., plantas recém germinadas, *Valls & al. 15014* (CEN). Mun. Ribeirão Cascalheira, 37 km ao sul de Cascalheira e 113 km ao norte de Água Boa na BR-158, junto de estrada que sai a leste, 390 m, 19-VIII-1984, *Valls & al. 7793* (CEN, CTES); 2,8 km ao norte do rio Turvo entre Água Boa e Cascalheira, ao longo da BR-158, 9-VI-1990, *Valls & al. 12525* (CEN, CTES); id., 6-XII-1996, *Silva & Werneck 3730* (CEN); id., 13°12'43"S, 51°54'42"W, 380 m, 19-X-2004, *Valls & al. 15029* (CEN); id., plantas recém germinadas, *Valls & al. 15030* (CEN); logo ao norte e a leste da ponte sobre o rio Turvo ao longo da rodovia BR-158, 40 km ao norte de Matinha, 13°13'32"S, 51°55'52"W, 9-VI-1990, *Valls & al. 12523* (CEN, CTES); id., 330 m, 14-XII-1996, *Silva & Werneck 3748* (CEN, CTES); id., 19-X-2004, *Valls & al. 15031* (CEN); id., plantas recém germinadas, *Valls & al. 15032* (CEN); id., plantas com sinais de contato com herbicida, *Valls & al. 15033* (CEN).

Geographic distribution: Brazil, Mato Grosso State, apparently restricted to the adjacent Água Boa, Canarana, Nova Nazaré and Ribeirão Cascalheira counties, on the water divide between the basins of Rio das Mortes, an affluent to the Araguaia, and several affluents to the Xingu river. Occurs mostly on shallow red soils topped by a layer of laterite pebbles. In Água Boa and Nova Nazaré, several populations occur sympatrically with *Arachis setinervosa* Krapov. & W.C. Greg. of the same section *Extranervosae*, where the new species obviously belongs, but no intermediate individuals have been observed.

Obs. 1. Krapovickas & Gregory (1994) tentatively identified some of the specimens now segregated under *Arachis submarginata* as allied to *A. Pietrarellii*, because the collections in the dry season were only fragmentary specimens. After examining new collections made at the onset of the dry season (Valls 12500 series), Krapovickas was able to discern that the specimens were a new species. New collections from December 1996 (Silva & Werneck series) allowed a firm establishment of the diagnostic morphological traits.

Obs. 2. Molecular marker (RAPD and RFLP) studies (Galgaro & al., 1998) have confirmed the distinction of the new species from *Arachis Pietrarellii*, which is strongly associated to *A. villosulicarpa* Hoehne, while *A. submarginata* clusters with *A. retusa* Krapov., W.C. Greg. & Valls, *A. Burchellii* and *A. prostrata*. Further RAPD studies (De Rosa, 1998) stress the close association of the several germplasm accessions of *A. submarginata* and their distinctiveness from all other species of section *Extranervosae*.

The specific epithet refers to the strongly marginate leaflets, which in vigorous plants bear a resemblance to *Arachis marginata* Gardner, complete to the unique type of leaf margin bristle.

### **3. *Arachis Pflugeae* C.E. Simpson, Krapov. & Valls *sp. nov.***

Fig. 3

*Arachidi subcoriacea* Krapov. & W.C. Greg. fere similis, sed foliolis molliusculis angustioribusque, internodis abbreviatis, foliis saepe subdigitatis differt.

*Holotypus hic designatus*: **BRASIL. Mato Grosso do Sul**: Mun. Porto Murtinho, 1,9 km a leste da estrada de acesso às fazendas Minha Mãe e Apaloosa, na rodovia Porto Murtinho-Jardim, BR-267, área muito perturbada em zona de mata baixa e espinhenta, solo lixiviado, ondulado, 21°44'51.3"S, 57°25'49.8"W, 190 m, 18-V-1994, J.F.M.Valls, R.C. Oliveira, A.K.Singh & G.P.Silva 13589 (CEN). *Isotipi*: BRIT, CGMS, CTES, CGMS, G, K, MO, NCSU, NY, P, RB, SP, TEX, US.

Perennial herb, densely branched, with delicate stems and thick tap root, up to 2 cm in diameter, with horizontal branching. Mainstem not apparent in mature plants, stems round in green tissue, quadrangular when dried. Lateral branches up to 23.4 cm long, at times developing partially underground. Internodes 1-19 cm long, partially covered by the adnate part of stipules. Lateral branch leaves tetrafoliolate, normally pinnate, but often appearing digitate due to an inconspicuous rachis, mostly in leaves at the basal part of the branches. Lateral branch leaflets linear, acute, mostly glabrous or with sparse hairs on top, hairy on bottom; margins thick, with bristles. Apical leaflet pair 20-35 mm long and 1.5-4 mm wide; basal pair 15-32 mm long, 1.5-8 mm wide. Petioles 2-24 mm long, rachis 1-3 mm long, but sometimes inconspicuous. No bristles on petiole or rachis. Stipules slightly hairy; adnate part 2-10 mm long, 1-2 mm wide, with 3-9 veins; free part 15-25 mm long. Hypanthium hairy, 2.5-4.7 cm long up to 9.3 cm in flowers of cultivated plants. Calyx purple, bilabiate, almost glabrous to hairy, but with bristles. Upper lip tridentate, 8 mm long, lower lip 9 mm. Standard petal orange or yellow, with orange lines in the yellowish throat, wings yellow with orange margins, both glabrous. Standard to 14 x 17 mm. Pegs

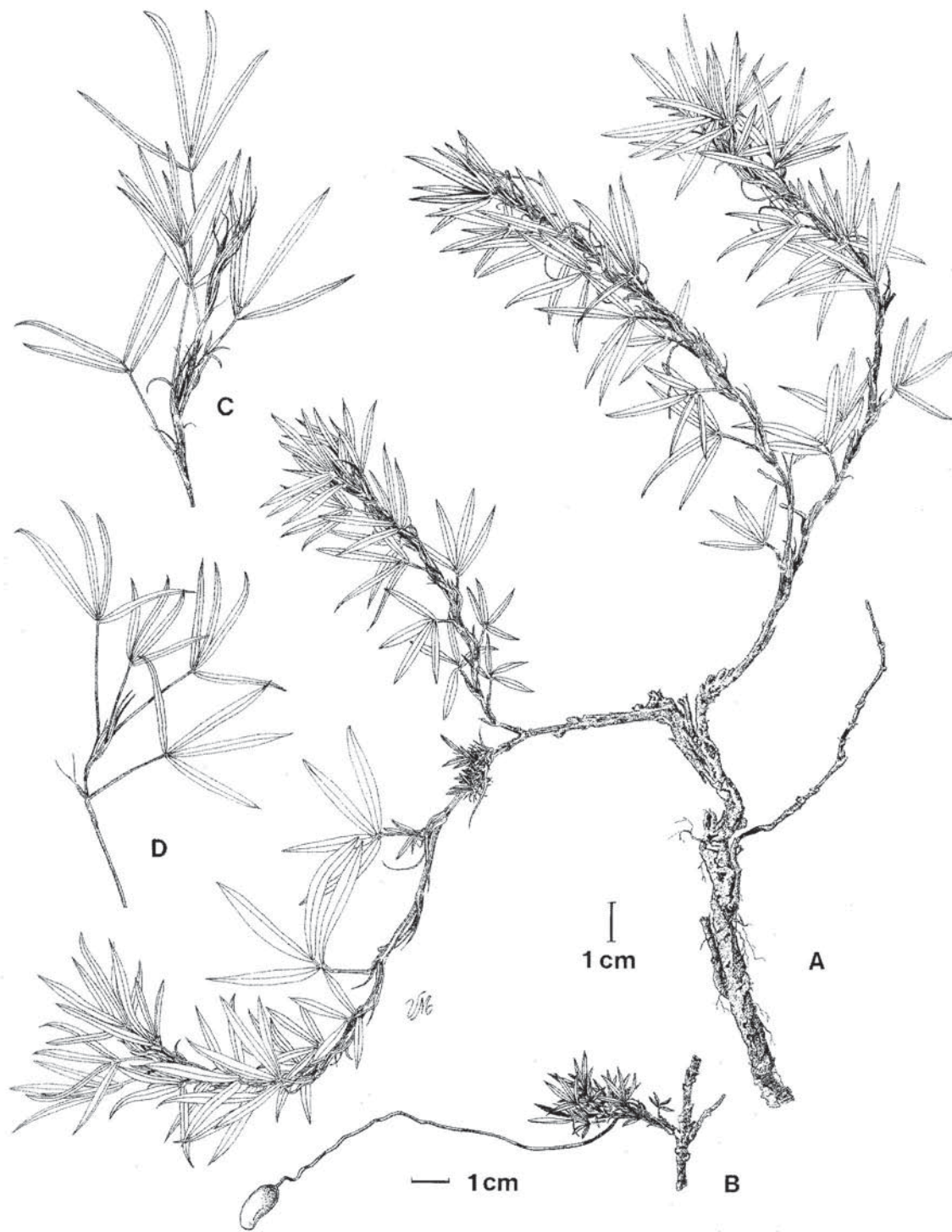


Fig. 3. *Arachis Pflugeae*. A: adult plant, showing thick root and short internodes mostly covered by stipules. B: branch with very short internodes, showing peg with developed fruit segment. C: tip of stem showing the most common pinnate leaves. D: tip of stem showing the less frequent digitate leaves, resulting from inconspicuous development of the rachis (A, Valls 13589. B, Valls 14050. C-D, Valls 13589, cultivated).



to 14 cm with many short hairs, but no bristles. Fruits up to 17 x 8 mm and mostly smooth with faint veins. Beak apparent.  $2n=20$  (Peñaloza & Valls, 2005).

*Paratypi*: **BRASIL. Mato Grosso do Sul**: Mun. Porto Murтинho, 1,5 km a leste da estrada de acesso à fazenda Minha Mãe, na rodovia Porto Murтинho-Jardim, BR-267, 17-II-1989, *A. Pott & al.* 4589 (CEN, CPAP); 1,9 km a leste da estrada de acesso às fazendas Minha Mãe e Apaloosa, na rodovia Porto Murтинho-Jardim, BR-267, 18-V-1994, *Valls & al.* 13591 (CEN); id., 21°44'S, 57°25'W, 3-V-1996, *Valls & al.* 14050, 14051 (CEN, CTES). **PARAGUAY. Concepción**: Zwischen rio Apa und rio Aquidaban, Centurión, 22°18'S, 57°35'W, 25-XI-1908, *Fiebrig* 4277 (US); km 25,2 na estrada Puentesño-San Carlos, 22°17' 04"S, 57°06'46"W, 190 m, 26-I-1997, *Silva & al.* 3777 (CEN, CTES); id., km 17,8, 22°17'54"S, 57°01' 24"W, 170 m, 26-I-1997, *Silva & al.* 3779 (CEN, CTES).

Geographic distribution: Brazil (Mato Grosso do Sul) and Paraguay (Dept. of Concepción), in the basins of the rivers Apa and Aquidaban.

Obs. 1. The type specimen of *Arachis Pflugeae* and cultivated plants transplanted from the original site have some leaves with an inconspicuous rachis, giving rise to a digitate arrangement of the four very narrow leaflets, resembling the trifoliolate leaves of *A. guaranitica* Chodat & Hassl. In nature, the mainstem of mature plants has usually been removed by grazing animals.

Obs. 2. An old herbarium collection of this new species, *Fiebrig* 4277, from Paraguay, has been identified as *Arachis angustifolia* (Chodat & Hassl.) Killip (Hoehne, 1940; Hermann, 1954) and as *A. stenophylla* (Krapovickas & Gregory, 1994). The name *A. angustifolia* is, in fact, based on two collections of *A. glabrata* var. *Hagenbeckii* (Harms ex Kuntze) F.J. Herm., both collected in Southern Paraguay, according to Krapovickas & Gregory (1994). With the segregation of *A. Pflugeae* as a different species, *A. stenophylla* is no longer cited to Paraguay.

Obs. 3. Molecular marker (RAPD) studies by Valente & al. (2003) strongly support the placement of *Arachis Pflugeae* in the section *Procumbentes*.

Obs. 4. *Arachis Pflugeae* shows very high cross-compatibility with species of sections *Procumbentes* and *Erectoides*. Several hybrids have been obtained with *A. appressipila* Krapov. & W.C. Greg. (accessions GKP 10002, V 9077), *A. Kretschmeri* Krapov. & W.C. Greg. (IRFL 2273), *A. lignosa* (Chodat & Hassl.) Krapov. & W.C. Greg. (V 13570), *A. Hermannii* Krapov. & W.C. Greg. (V 7560), and *A. paraguariensis* Chodat & Hassl. subsp. *paraguariensis* (V 7677) (Teixeira & Valls, 1998). The hybrid with *A. paraguariensis* is surprisingly fertile and 13 F<sub>1</sub> individuals, with pollen counts up to 68% have all produced F<sub>2</sub> seed, which germinated well, showing a broad array of morphological segregation (Rodrigues & Valls, 2002, 2003). This is the first fertile intersectional hybrid obtained in the genus *Arachis*.

This species is named and described in dedication to the late Dr. Margaret Pfluge Gregory, formerly of the Department of Biological Sciences, North Carolina State University. Dr. M.P. Gregory labored many years along side her husband, Dr. W.C. Gregory, in their efforts to characterize the many *Arachis* species through morphological data, cross-compatibility studies and cytological analyses.

#### **4. *Arachis Hassleri* Krapov., Valls & C.E. Simpson *sp. nov.***

Fig. 4

*Arachidi retusae* Krapov., W.C. Greg. & Valls primo aspectu fere similis, sed radicibus non tuberculatis et vexillo sine lineis dorsalibus differt. Ab *A. lignosa* (Chodat & Hassl.) Krapov. & W.C. Greg. foliolis emarginatis, calyce setoso, fructibus glabris distinguenda.

*Holotypus hic designatus*: **PARAGUAY. Concepción**: Aproximadamente 20 km a nordeste de



Fig. 4. *Arachis Hassleri*. A: adult plant, showing thick root and lignified base of branches. B: adult plant, showing peg with developed fruit segment. C: leaf, showing emarginate tip of leaflets (*Silva 3818*).

Concepción, na periferia da cidade de Loreto, erva rastejante em local muito perturbado, solo argiloso coberto com areia, área plana, 23°23'28"S, 57°25'30"W, 100 m, 2-II-1997, G.P. Silva, E.A. Pizarro & R. Heyn 3818 (CEN). *Isotypi*: BM, BRIT, CTES, FCQ, G, K, MO, NY, P, PY, RB, SI, SP, TEX, UC, US.

Perennial herb, with delicate stems usually lignified towards the densely branched crown. Tap root, up to 12 mm in diameter in old plants. Mainstems short, rounded in green, angular in dry specimen; internodes short, covered by the stipules. Leaves tetrafoliolate, glabrescent. Lateral branches rounded in green tissue, angular when dry, 13-61 cm long; internodes short and mostly covered by the stipules. Lateral branch leaves with sparse hairs on petiole, rachis, and margins. Bottom of leaflets with many short, adpressed hairs, margin and mid-vein prominent. Leaflets obcordate, indentate. Apical pair 6.8-21.5 mm long and 5.2-13.6 mm wide; basal pair 5.8-19.4 mm long, 3.3-10.3 mm wide. Petioles 6-45 mm long, rachis 2.7-9.8 mm long. Stipules slightly hairy on margins, 0.7-2.8 mm wide, with 3-11 visible veins. Adnate part 3.1-10.2 mm long; free part 5.6-14.7 mm long. Hypanthium purplish, hairy, 3.5-7.1 cm long. Calyx purple, bilabiate, with sparse bristles. Upper lip tridentate, 6 mm long; lower lip 7 mm long. Standard petal of strong lemon yellow color, with orange lines; wings yellow. Standard to 17 mm long, 13 mm wide. Pegs horizontal, to 10 cm long in pressed specimens, with no bristles. Fruits up to 14 X 6 mm, mostly smooth, with pronounced beak and no hairs.  $2n=20$  (Peñaloza & Valls, 2005).

*Paratypes*: **PARAGUAY. Boquerón**: Palmas Chicas, campo, entre arbustos, herba prostrada ptl. amarillas, XII-1937, Rojas 7623 (CTES, SI). **Concepción**: Road from Concepción to Loreto, 23°23'47.9"S; 57°25'26.7"W, 78 m, 20-V-2002, M.J. Williams & al. 950 (CTES). **Presidente Hayes**: Gran Chaco. Ad ripam occidentalem flum. latit. S 23°20' - 23°30', X-1903, Hassler 2422 (NY).

Geographic distribution: So far, only known from Paraguay, at Concepción and Loreto and west of the Paraguay River near

Concepción, and also from Palmas Chicas, near the Brazilian border along the Paraguay River.

Obs. 1. The above-ground growth of this species presents a strong morphological resemblance to *Arachis retusa*, of section *Extranervosae*, the only other species of *Arachis* with emarginate leaflets. However no markings are shown in the back of the standard and the root system does not have tuberous enlargements on the roots, thus differentiating it from *A. retusa*. The root system associates the species with section *Procumbentes*.

Obs. 2. The new species has similarities to *Arachis lignosa*, and could be confused with that species. However, there are five distinguishing characters: 1. *A. Hassleri* has adpressed hairs on the lower surface of the leaves, *A. lignosa* does not; 2. *A. lignosa* has short hairs on the upper surface of leaves, *A. Hassleri* does not; 3. *A. Hassleri* has emarginated leaflets, *A. lignosa* does not; 4. *A. Hassleri* has bristles on the calyx, *A. lignosa* does not; 5. Fruits of *A. lignosa* are pubescent, fruits of *A. Hassleri* are not hairy.

We dedicate this species to Émile Hassler, Swiss botanist, who made important collections of wild species of *Arachis*, including this one, in Paraguay.

### 5. *Arachis interrupta* Valls & C.E. Simpson *sp. nov.*

Fig. 5

*Arachidi Dardani* Krapov. & W.C. Greg. *affinis, sed canalibus petiolorum inter foliola basalia transverse ciliatis distinguenda.*

*Holotypus hic designatus*: **BRASIL. Minas Gerais**: Mun. Monte Azul, 300 m a leste da ponte sobre o rio Verde Grande em Gado Bravo, área de caatinga arbustiva com vegetação herbácea rala, solo limo-arenoso friável, mas compactado na superfície, plano, 14°56'S, 43°36'W, 470 m, 31-V-1991, J.F.M. Valls, E.A. Pizarro, L. Faraco &

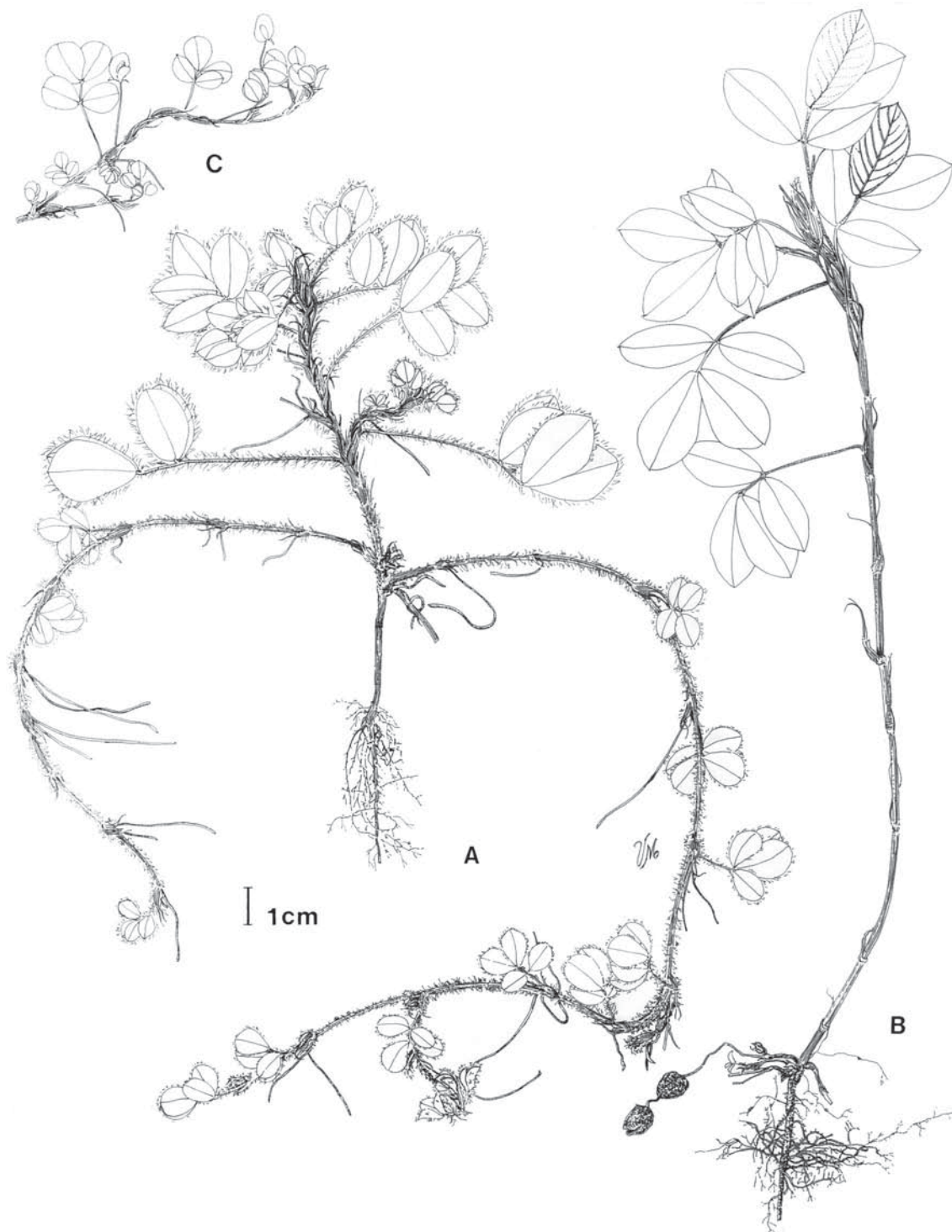


Fig. 5. *Arachis interrupta*. A: plant with short mainstem and normal lateral branches with pegs, collected in 1991 (Valls 13082). B: plant showing predominant development of mainstem, with short lateral branches, collected in III-1993 (Werneck 148). C: tip of lateral branch with flowers, collected in IV-1996 (Werneck 819).

*G.P. Silva 13082* (CEN). *Isotypi*: BHCB, BM, BRIT, CTES, G, GH, IPA, K, MO, NY, P, RB, SI, SP, TEX, UEFS, US.

Annual herb, with fine tap root 2-4 mm in diameter, and delicate, hairy stems. Mainstems angular when dried, 7.5 to 54.7 cm in height, mainstem internodes 1-20 mm long, hairy. Mainstem leaves tetrafoliolate; leaflets glabrous or slightly pubescent on top, hairy on bottom and margins. Apical pair 11-30 mm long, 8-21 mm wide; basal pair 9-30 mm long, 6-18 mm wide. Petiole 10-58 mm long; rachis 3-18 mm long. Petiole canal interrupted by a fringe of hairs at the insertion of the basal leaflets. No bristles on petiole or on leaflet margins and surfaces. Stipules on mainstem leaves with marginal hairs only, and no bristles. Adnate part 3-9 mm long, 1.5-2 mm wide. Free part of stipule 8-17 mm long. Lateral branches 12.4-70.5 cm long, with many hairs. Leaves on lateral branches tetrafoliolate; leaflets obovate, glabrous or slightly pubescent on top, hairy on bottom and margins. Apical pair 9-30 mm long, 6-21 mm wide; basal pair 9-19 mm long, 7-11 mm wide. Petiole 5-23 mm long; rachis 3-8 mm long. Petiole canal also interrupted with fringe of hairs. No bristles on petiole or on leaflet margins and surfaces. Stipules on lateral branches with marginal hairs only, and no bristles. Adnate part 3-6 mm long, 1-2 mm wide. Free part of stipule 5-23 mm long. Hypanthium 2.8-3 cm long, with numerous fine hairs. Calyx bilabiate with many fine hairs to 1 mm, but no bristles. Upper lip 4 mm long, 3.2 mm wide, tetradentate; lower lip 5 mm long, 1.6 mm wide. Standard petal orange, wings yellow; both glabrous. Standard to 8.5 mm long, 10 mm wide, with dark orange spots in throat, faint lines on back; wings to 6 mm long. Pegs to 7.8 cm, with many hairs but no bristles. Fruit segments 8 mm long x 6 mm wide to 12 mm long x 8 mm wide and mostly smooth with faint veins but some segments with slight reticulation. The beak is not apparent. Fruits losing thin exocarp at maturity to expose black endocarp layer with pronounced veins. Isthmus short, usually 25-39 mm long.  $2n=20$  (Peñaloza & Valls, 2005).

*Paratypes*: **BRASIL. Minas Gerais**: Mun. Monte Azul, 300 m a leste da ponte sobre o rio Verde Grande em Gado Bravo, 14°56'S, 43°36'W, 470 m, 8-III-1993, *Werneck 148* (CEN); id., 6-IV-1996, *Werneck 819* (CEN).

Other materials studied: **UNITED STATES OF AMERICA. Texas**: Stephenville, 30°14'N, 98°11'W, 400 m. Cultivated from seed of *Valls & al. 13082*, 7-IV-1995, *Simpson 2718* (CEN).

Geographic distribution: Only known from the type location in the municipality of Monte Azul, Minas Gerais State, Brazil, 300 m to the east of river Verde Grande, in Gado Bravo.

Obs. 1. Morphologically associated to *Arachis Dardani*, but is differentiated by a fringe of hairs at the insertion of the basal leaflets interrupting the petiole canal. This fringe of hairs is the primary separation of *A. Dardani* and *A. interrupta* and is the basis for the specific epithet.

Obs. 2. The fringe of hairs at the insertion of the basal leaflets is a common feature of almost all *Arachis* species except *A. Dardani*, thus is a useful trait to separate *A. Dardani* and *A. interrupta*.

Obs. 3. Molecular marker (RAPD) studies (Souza, 1997, Coelho & al., 2001) have confirmed the close association of *Arachis interrupta* to the remaining species of section *Heteranthea*.

## **6. *Arachis seridoënsis* Valls, C.E. Simpson, Krapov. & R. Veiga sp. nov.**

Fig. 6

*Arachidi pusillae* Benth. et *A. sylvestri* (A. Chev.) A. Chev. similis, sed foliolis cum pilis aureis dorsalibus et ventralibus, stipulis setosis et foliolis sine setis differt.

*Holotypus hic designatus*: **BRASIL. Rio Grande do Norte**: Mun. Acari, km 17 da rodovia BR-427, 10 km a nordeste de Acari em direção a Currais Novos, local arborizado ao longo de rio com leite

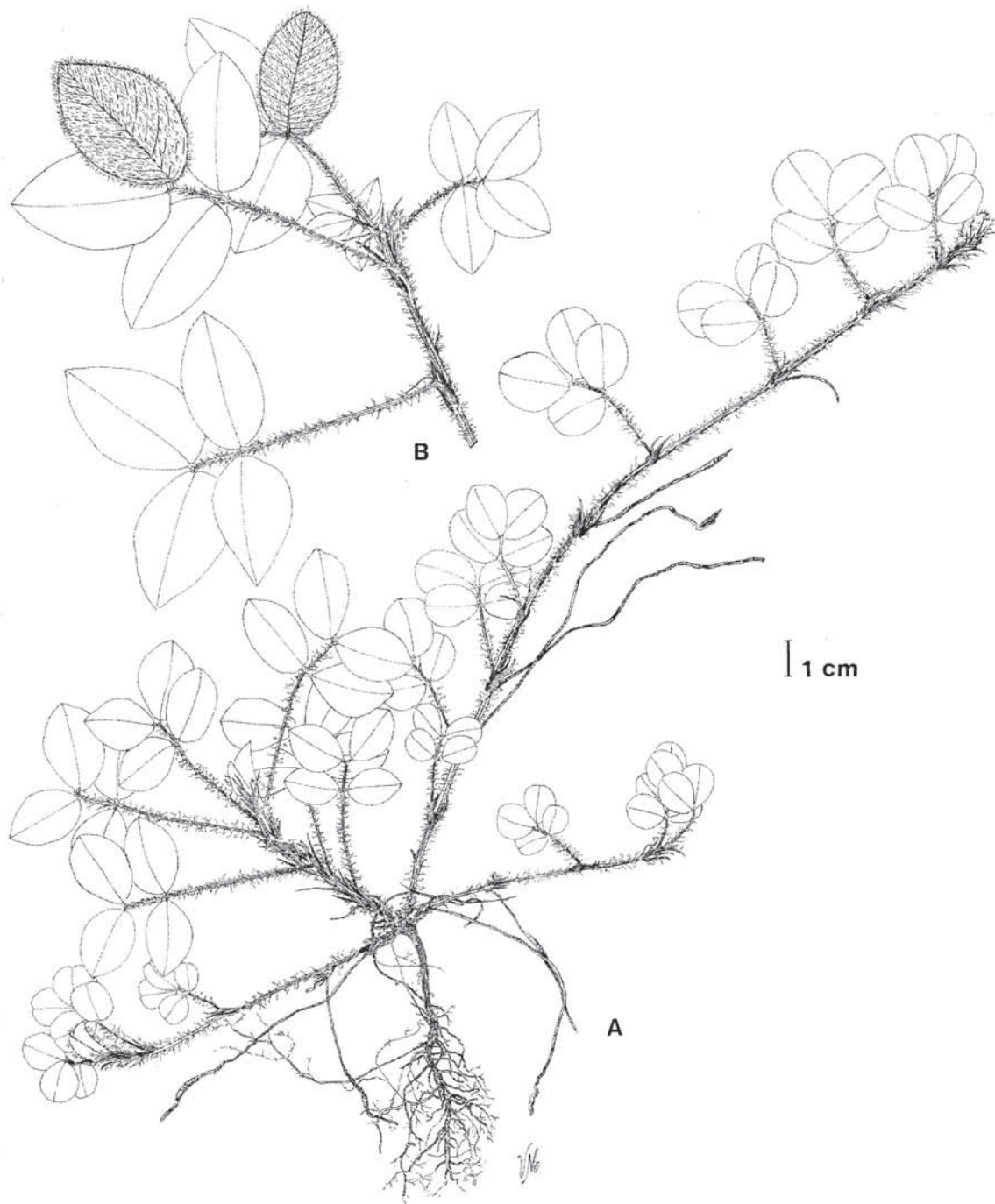


Fig. 6. *Arachis seridoënsis*. A: plant with lateral branches and pegs (Valls 10969). B: tip of large mainstem from cultivated plant (Valls 13902).

pedregoso, solo arenoso com grava acumulado ao longo da estrada, declive suave, 06°21'S, 36°37'W, 210 m, 24-IV-1987, *J.F.M. Valls, V.R. Rao & G.P. Silva 10969* (CEN). *Isotypi*: BRIT, CTES, G, IPA, K, MO, NY, P, RB, SI, SP, TEX, UEFS, US.

Annual herb with densely hairy, delicate stems. Tap root 2-4 mm in diameter. Mainstem rounded in green tissue, becoming angular when dry, 1.1-8.4 cm long; in cultivated specimen up to 48 cm; internodes up to 12 mm long, covered by the stipules in short (natural) specimens. Mainstem leaves tetrafoliolate, pubescent on top, densely hairy on bottom and margins. Apical pair 11-28 mm long, 7-19 mm wide; basal pair 16-25 mm long, 5-15 mm wide. Petioles 16-52 mm long; rachis 6-12 mm long. Stipules very hairy; adnate part 3-8 mm long; free part 6-14 mm long, with scattered bristles. Lateral branches round in green tissue, angular when dry; 2-20 cm long, with purplish internodes and tetrafoliolate leaves. Internode length 3-26 mm. Lateral branch leaflets rounded. Apical pair 11-19 mm long and 8-18 mm wide; basal pair 8-17 mm long, 7-13 mm wide. Leaflets pubescent on top, densely hairy on bottom and margins, with two types of hairs; medium length and very long (to 4 mm), golden. No bristles on leaflets but some longer hairs often appear to be bristles. Petioles 10-29 mm long, rachis 4-9 mm long, pubescent and with occasional bristles. Adnate part of stipules on lateral branches 2-5 mm long; free part 4-9 mm long, with two types of hairs and occasional bristles. Hypanthium on normal flowers, 2.1 cm long with numerous fine hairs to 1.5 mm, minute cleistogamic flowers to 2 mm in most material from nature or cultivated in South America. Small cleistogamic flowers rarely observed in material cultivated in USA. Calyx bilabiate, light green, with long hairs but no bristles. Upper lip tetradentate; lower lip narrow, acute. Standard petal pale yellow, with faint lines, and markings in throat. Back of standard pale yellow to purplish, almost purple at edges, wings yellow. Standard to 7-8 x 9-10 mm. Pegs up to 12.6 cm long. Fruit segments up to 12 x 7 mm, mostly smooth or with slight reticulation but covered with den-

se, short hairs. Peg attachment with a distinct nipple appearance.  $2n=20$  (Peñaloza & Valls, 2005).

*Paratypus*: **BRASIL. Distrito Federal:** Brasília. Cultivada em vasos em telado da Embrapa Cenargen, a partir de sementes do acesso *Valls & al. 10969*, 10-X-1995, *Valls 13902* (CEN).

Geographic distribution: Only known from the type location at Rio Grande do Norte State, in the area known as the Seridó region, the driest part of the semi-arid Brazilian Northeast. The specific epithet refers to this Seridó region where the species was collected.

Obs. 1. Morphological and isoenzymatic studies conducted by R. Veiga, at IAC, have discriminated this species from *Arachis sylvestris* (Veiga & al., 1999).

Obs. 2. Molecular marker (RAPD) studies (Souza, 1997, Coelho & al., 2001) have confirmed the close association of *Arachis seridoënsis* to the remaining species of section *Heterantheae*.

### 7. *Arachis nitida* Valls, Krapov. & C.E. Simpson *sp. nov.*

Fig. 7

*Ab Arachide glabrata* Benth. *foliolis minoribus, coriaceis, antice nitidi differt. Arachidi Burkartii Handro primo adspectu fere similis, vexillo sine lineis dorsalibus recedit.*

*Holotypus hic designatus*: **BRASIL. Mato Grosso do Sul:** Mun. Porto Murtinho, 34,4 km a leste da cidade, na rodovia BR-267, e então 16,4 km em direção sul na estrada para a Colônia Cachoeira, borda de mata rala perturbada ao longo da estrada, solo limo-arenoso cinzento claro com cascalho, suavemente ondulado, 21°52'35"S, 57°34'26"W, 200 m, 2-V-1996, *J.F.M. Valls, J.P. Moss, E.A. Pizarro & W.L. Werneck 14040* (CEN). *Isotypus*: CTES.

Rhizomatous, perennial herb, with thick

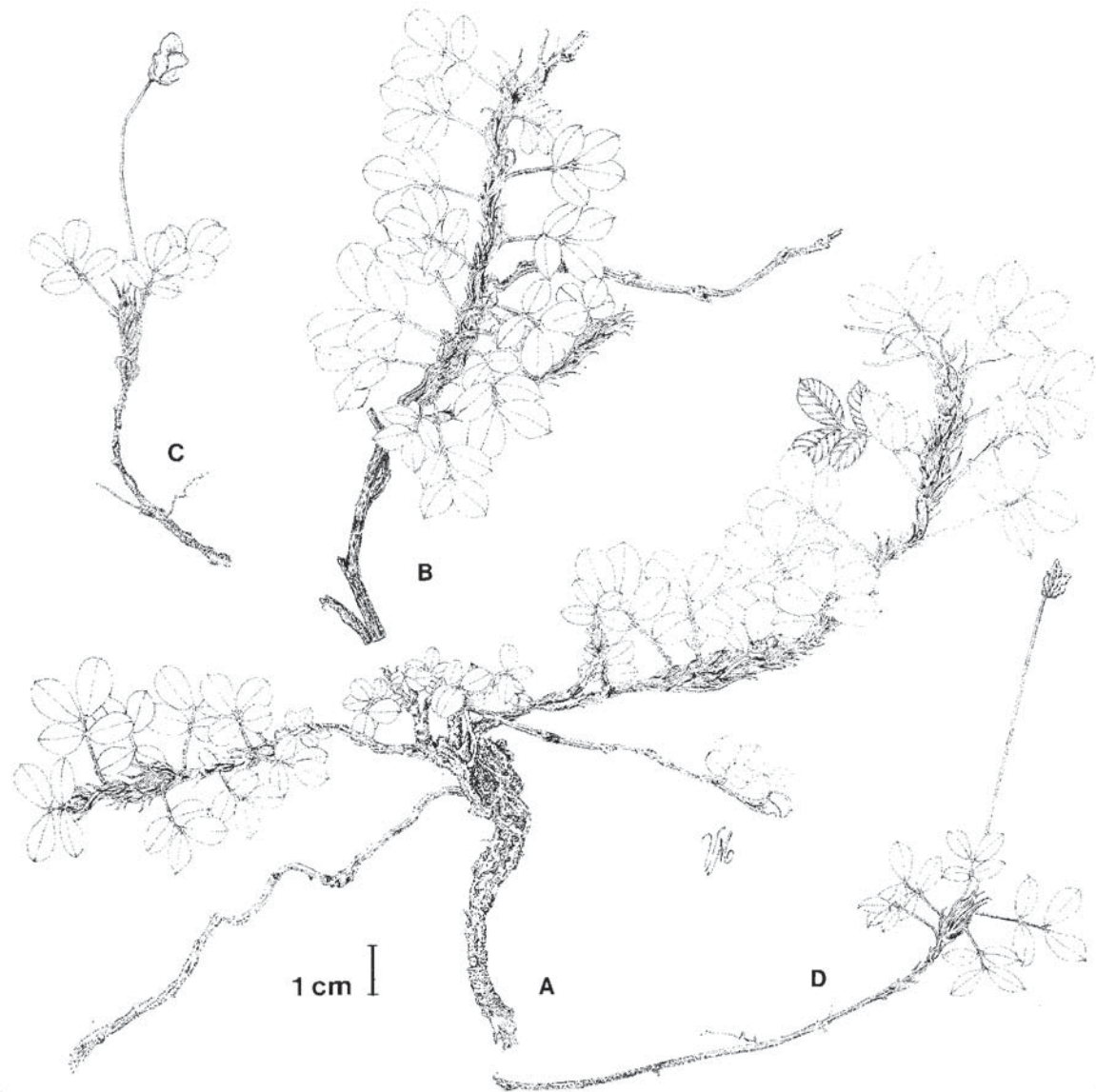


Fig. 7. *Arachis nitida*. A: adult plant, showing thick root system and short internodes mostly covered by stipules. B: branch with short internodes covered by stipules, showing developing rhizome. C-D: tips of branches, showing subterminal flowers (Valls 14040).



roots and delicate rhizomes and stems. Mainstem not apparent. Lateral branches usually round in green tissue, quadrangular in dried specimen; 13–18.6 cm long, with short internodes, about 1–2 cm long, mostly covered by the adnate part of the stipules. Leaves on lateral branches tetrafoliolate; leaflets obovate to elliptic, glabrous on top, many fine, adpressed hairs on bottom to 0.5 mm; many fine hairs and scattered bristles on margins. Apical leaflet pair 10–17 mm long, 6–8 mm wide; basal pair 9–13 mm long, 5.5–7 mm wide. Leaflets strongly marginated on the bottom surface and mid-vein. Petioles 6–17 mm long, rachis 3–6 mm long. Petiole much broader than rachis, both with some fine, short hairs, but no bristles; both deeply grooved. Stipules on lateral branches with few hairs, only occasional bristles. Adnate part 4–5 mm long, 2 mm wide; free part of stipules 6–12 mm long. Stipules with 3–5 veins. Hypanthium purplish, 4.7–6.9 cm long (to 10.1 cm in cultivated specimens) with numerous fine hairs to 1 mm, no bristles. Calyx bilabiate, purplish, with many bristles, upper lip tetradentate, 8 mm long, lower lip 10 mm long. Standard petal orange or yellow, with orange lines in throat, wings yellow, standard and wings both glabrous. Standard to 19–20 mm x 15 mm; wings to 9 mm. Wings open on the front side approximately 3–4 mm. Pegs to 52 mm, with many fine, short hairs.  $2n=40$  (Peñaloza & Valls, 2005).

*Paratypes*: **BRASIL. Mato Grosso do Sul**: Mun. Porto Murtinho, 51 km E of Porto Murtinho, (estrada BR 34, beside a small river) 12-IV-1968, *Hammons & al.* 569 (CEN, CTES). **PARAGUAY. Amambay**: Km 41,8 na estrada Bella Vista - Puentesíño, flor laranja, 22°23'47"S, 56°38'44"W, 200 m, 27-I-1997, *Silva & al.* 3782 (CEN); id., flor amarela, *Silva & al.* 3783 (CEN); km 21 na estrada Bella Vista - Puentesíño, 22°18'36"S, 56°31'28"W, 180 m, 27-I-1997, *Silva & al.* 3785 (CEN); km 83,7 na estrada Bella Vista - intersecção Yby-Yau, 22°41'00"S, 56°18'05"W, 230 m, *Silva & al.* 3790 (CEN). **Concepción**: Km 14,8 na estrada San Carlos - Puentesíño, flor amarela, 22°19'06"S, 57°14'11"W, 180 m, 25-I-1997, *Silva & al.* 3771 (CEN); id., flor laranja, *Silva & al.* 3772 (CEN); id., km 19,8,

22°19'19"S, 57°11'43"W, 180 m, 25-I-1997, *Silva & al.* 3774 (CEN); km 25,2 na estrada Puentesíño - San Carlos, 22°17'04"S, 57°06'46"W, 190 m, 26-I-1997, *Silva & al.* 3778 (CEN); km 39,5 na estrada Paso Loreto - Puentesíño, flor amarela, 22°55'55"S, 56°54'01"W, 100 m, 1-II-1997, *Silva & al.* 3810 (CEN); id., flor laranja, *Silva & al.* 3811 (CEN); km 9,6 na estrada Paso Loreto - Colonia Jorge Sebastian Miranda, 23°02'18"S, 57°03'06"W, 100 m, 1-II-1997, *Silva & al.* 3816 (CEN); km 16,5 na estrada Concepción - Loreto, 23°19'27"S, 57°18'57"W, 100 m, 1-X-1997, *Silva & al.* 3823 (CEN); km 48,9 na estrada rio Aquidaban - Puentesíño, flor laranja, 22°53'01"S, 56°51'36"W, 230 m, 4-X-1997, *Silva & al.* 3835 (CEN); id., flor amarela, *Silva & al.* 3836 (CEN).

Geographic distribution: Brazil, mostly in the valley of the Apa river, in Mato Grosso do Sul, and Paraguay, in the Amambay and Concepción Departments.

Obs. 1. It is not common to see a mainstem of *Arachis nitida* because they are usually removed by grazing, especially in mature plants.

Obs. 2. *Arachis nitida* (accession HLKHe 569) has been crossed to *A. Batizocoi* Krapov. & W.C. Greg. (K 9484) and their hybrid has been the only representative of sections *Arachis* X *Rhizomatosae* to produce flowers. A hybrid with *A. major* Krapov. & W.C. Greg. (HLKHe 559) yielded a pollen count of 29.6% (Krapovickas & Gregory, 1994).

Obs. 3. Several accessions were collected from Paraguay with only yellow flowers. Flowers in other populations were either orange, or mixed orange and yellow.

Obs. 4. Recent studies using RAPD markers (Nóbile & al., 2004) support the distinction of *Arachis nitida* and, at the same time, its close association to the other tetraploid species of section *Rhizomatosae*.

The specific epithet refers to the shiny surface of the coriaceous, dark green leaflets, which resemble those of *Arachis Burkartii*, a diploid species of the same section with a southern distribution in Argentina, Brazil (Rio

Grande do Sul State only) and Uruguay.

**8. *Arachis linearifolia* Valls, Krapov. & C.E. Simpson sp. nov.**

Fig. 8

*Arachidi Diogoi* Hoehne affinis, sed foliolis coriaceis, laevibus, angustioribus et concoloribus differt. Ab *A. subcoriacea* Krapov. & W.C. Greg. primo adspectu fere similis paxillo multo brevioribus non horizontalibus distinguenda.

*Holotypus hic designatus: BRASIL. Mato Grosso:* Mun. Santo Antonio do Leverger, 4,6 km de Santo Antonio, na estrada para Barão de Melgaço, savana inundável de lixeira e gramíneas, com murundús, solo limo-arenoso sobre argila com concreções ferrosas, plano com micro-relevo, 15°53'S, 56°02'W, 110 m, 27-X-1985, J.F.M. Valls, A. Pott & L.B. Bianchetti 9401 (CEN). *Isotypi:* BRIT, CTES, K, MO, P, R, RB, SP, UFMT.

Perennial herb, with fleshy, delicate stems. Tap root up to 1.5 cm in diameter. Mainstems round in fresh specimens but usually angular when dry, 1.3-9.3 cm in height, internodes 4-10 mm long. Occasional mainstems without bristles, but scattered presence on most plants. Mainstem leaves tetrafoliolate, with scattered hairs at the edges of the leaflets. Apical pair of leaflets 15-23 mm long, 3 mm wide; basal leaflets 14-29 mm long, 3 mm wide. Leaflets mostly glabrous on top and with many short adpressed hairs on bottom, with hairy pulvinus and a long fringe of hairs between the basal leaflets. Mid-vein and margin strongly evident, bristles sparsely spaced on leaflet margins. Mainstem leaf petiole 14-35 mm long; rachis 4-11 mm long. Adnate part of mainstem stipules 3-6 mm long. Free part of stipule 3-8 mm long, 1 mm wide, with 3 visible veins. Creeping lateral branches round but somewhat angular when dried, 18.6-66.8 cm long. Older lateral branches usually buried by accumulation of soil, lignified, and sprouting from buried buds. Internode length 2.5-4.9 cm. Lateral branch leaflets linear, fleshy, glabrous on top, sometimes with scattered

hairs on leaflet bottom, with strongly evident mid-vein. Apical leaflet pair 15-32 mm long and 3-6 mm wide; basal leaflets 11-28 mm long, 2-5 mm wide. Leaflets glabrous on top, with scattered hairs and bristles on margins. Petioles 5-13 mm long, with few hairs and scattered bristles, deeply grooved; rachis 4-7 mm long. Stipules on lateral branches with few hairs and scattered bristles. Adnate part of stipules 2.5-5 mm long; free part 7-16 mm long, 2-4 mm wide, with 4-10 evident veins. Hypanthium purplish, pubescent, especially at base, 5.5-9.3 cm long. Calyx bilabiate, green with pink spots, glabrescent or pubescent, with scattered to numerous bristles. Upper lip tetradentate, 6 mm long, lower lip 7 mm long. Standard petal orange or yellow, with reddish lines in flower throat, wings yellow. Standard to 12-19 X 14-18 mm. Pegs to 5.6 cm in pressed specimens. Fruits up to 12 x 6 mm, smooth. 2n=20 (Peñaloza & Valls, 2005).

*Paratypes: BRASIL. Mato Grosso:* Mun. Santo Antonio do Leverger, 4.6 km de Santo Antonio, na estrada para Barão de Melgaço, 15°53'S, 56° 02'W, 27-X-1985, Valls & al. 9402 (CEN, CTES); id., plantas recém germinadas, Valls & al. 9403 (CEN, CTES); id., 24-I-1989, Valls & Krapovickas 12080 (CEN, CTES); id., 30-IV-1995, Valls & al. 13783 (CEN, CTES).

Geographic distribution: Only known from the type location, 4.6-4.7 km south of Santo Antonio do Leverger, in the state of Mato Grosso, Brazil, growing in a low, often inundated, grassy, semi-forested area.

Obs. 1. The new species shows strong morphological similarities to *Arachis Diogoi*, to which it has also been associated in molecular marker (RAPD) studies (Valente & al., 2003), but its leaflets are more fleshy and glabrous, not as markedly bicolor as in *A. Diogoi*, and much more linear.

Obs. 2. The molecular marker studies cited in Obs. 1 support a strong distinction of *Arachis subcoriacea*, to which specimens of this collection were assigned in the monograph (Krapovickas & Gregory, 1994). *A. subcoriacea* has glabrous pulvini, a shallower petiole



Fig. 8. *Arachis linearifolia*. A: adult plant, showing intensive basal branching. B: seedling, showing larger mainstem leaves. C: branch segment, showing long internode with the adnate part of the stipules barely covering any part of the stem (Valls 9401).

groove, and the adnate and free parts of the stipules are almost the same length, while the free part is almost three times longer than the adnate part in *A. linearifolia*.

Obs. 3. Crosses with *Arachis stenosperma* Krapov. & W.C. Greg. (accession HLK 410) yielded pollen counts of 53.9%. With distinct cultivars of *A. hypogaea*, counts reached 2.8 to 3.2% (Spantex), 4.1-8.0% (Tamnut 74), and 9.5 to 12.1% (NC 7) (Simpson, C.E., unpublished).

Obs. 4. *Arachis linearifolia* also belongs to the group of section *Arachis* species which has the small "A" chromosome pair (Peñaloza & Valls, 2005).

The specific epithet refers to the very narrow leaflets, which may take an upright position, when the species grows in dense grass stands.

**9. *Arachis Schinini* Krapov., Valls & C.E. Simpson *sp. nov.***

Fig. 9

*Arachidi Hoehnei* Krapov. & W.C. Greg. *affinis*, sed ramis lateralibus plerumque longioribus, petiolis abbreviatis, canalibus petiolorum latioribus et vexilli lineis aurantiacis differt.

*Holotypus hic designatus: PARAGUAY. Amambay:* Logo ao norte do Arroyo Negla, 35 km ao sul de Bella Vista, na estrada para o sul do Paraguai, cerrado perturbado, solo areno-argiloso avermelhado a cinzento, declive suave, 22°23'S, 56°24'W, 200 m, 8-IV-1986, J.F.M. Valls, C.E. Simpson & W.L. Werneck 9923 (CEN). *Isotypi:* BRIT, CTES, G, GH, K, LIL, MO, NY, PY, RB, SI, SP, US.

Annual herb, with tap root, some 7 mm thick, with slender branching. Mainstem erect, up to 103 cm long, upper internodes short, covered by the stipules; lateral branches procumbent, extended, some 0.1-2.1 m long, sparsely branched. Stems angular and densely villous, internodes up to 4.5 cm long in lateral

branches. Leaves tetrafoliolate, those in the mainstem much larger than in the lateral branches. Stipules on mainstem with adnate part to 15 mm long, free portion to 22 mm long; stipules with many long and short hairs and bristles on dorsal face. Bristles few on the free part of stipules. Petioles up to 24 mm long and rachis reaching 12 mm. Apical leaflets up to 40 x 17 mm; basal leaflets to 33 x 16 mm, leaflets lanceolate. Many specimens with very long hairs to 3 mm on lower surface of younger main axis leaflets. Stipules on lateral branches with adnate part 4-10 mm long and free part to 12 mm long. Petioles 14 mm long and rachis 5 mm long. Apical leaflets 15-21 x 9-14.5 mm; basal pair 12-19 x 8-11.5 mm, leaflets obovate, apiculate. Stipules with adnate part villous, especially along the dorsal line and with sparse bristles, including bristles on free part, and margins with long bristles. Adnate part to 10 mm long and 5 mm wide, free part to 12 mm long and 3 mm wide. Petioles and rachis dorsally villous, with a few bristles. Upper surface canaliculate, tomentous; rachis noticeably narrower than petiole. Leaflets hairy on both surfaces, epiphyll pubescent, with sparse hairs about 2 mm long, those slightly more abundant in the hypophyll; mid-vein and edges slightly prominent in the hypophyll, edges long-ciliate and with a few bristles. Flowers along the lateral branches in very short axillary spikes. Hypanthium 22-54 mm long, quite villous, light green. Calyx light green, villous and with many bristles; upper lip 7-8 mm long; lower lip falcate, narrow, 8-9.5 mm long. Standard petal faint orange, with orange lines and yellow throat, 14 mm high x 15-19 mm wide, wings yellowish towards the base, orange at the tip. Peg villous in the aerial part. Fruit segments plump and smooth, with a curved beak, 14 to 17 mm long. 2n=20 (Peñaloza & Valls, 2005).

*Paratypi: PARAGUAY. Amambay:* Ruta 3, arroyo Negla, 35 km S de Bella Vista, 24-VIII-1980, *Schinini & Bordas* 20563 (CTES); id., 21-IX-1981, *Schinini* 21450 (CTES); id., 16-XII-1983, *Vanni & al.* 327 (CTES); id., *Vanni & al.* 345 (CTES); id., 25-II-1994, *Krapovickas & Cristóbal* 45023 (CTES); km 37 na estrada Bella Vista



Fig. 9. *Arachis Schinini*. A: adult plant, showing long mainstem. B: tip of lateral branch, showing flower and pegs (Valls 14183, cultivated).

- Yby Yaú, 22°21'10" S, 56°19'41"W, 250 m, 28-1-1997, *Silva & al.* 3794 (CEN).

Other materials studied: **BRAZIL. Distrito Federal:** Brasília. Cultivada em vasos em telado da Embrapa Cenargen, a partir de sementes do acesso *Valls & al.* 9923, *Valls 14183* (CEN).

Geographic distribution: Only known from the type location, where it has been collected several times, south of Bella Vista, at Arroyo Negla (Paraguay).

Obs. 1. Specimens of *Arachis Schininii* were placed among the additional materials of *A. Hoehnei* in the monograph of the genus (Krapovickas & Gregory, 1994). However, the species can be differentiated by a series of tenuous morphological characters and ultimately by their cytological features and crossing data. *A. Schininii* is coarser than *A. Hoehnei*, showing longer lateral branches, broader petiole canal and orange lines in the standard petal. Standard lines are red in *A. Hoehnei*, which also shows narrower stipules. The petioles on the lateral branches of *A. Schininii* are noticeably shorter than in *A. Hoehnei*. The long hairs in the leaflets are denser in *A. Schininii*. The small "A" chromosome pair is present in *A. Schininii* (Peñaloza & Valls, 2005), but is absent in *A. Hoehnei* (Fernández & Krapovickas, 1994).

Obs. 2. By having both leaflet surfaces villous, *Arachis Schininii* may also be compared with *A. villosa*, where, however the epiphyll hairs are short, ca. 1 mm long, and curled. Furthermore, the edge of the leaflets is always thickened in *A. villosa*.

Obs. 3. Crosses with *Arachis Hoehnei* (accession K 30006) yielded pollen counts of 20%, 25.2% and 25.6%. Much lower counts were obtained in hybrids with *A. Batizocoi* (K 9484), 0-0.7%, and with *A. duranensis* Krapov. & W.C. Greg. (K 7988), 4.2%. Pollen counts from crosses with *A. hypogaea* cv. Tamnut 74 reached 2.8% to 6%.

Obs. 4. With the present segregation of

*Arachis Schininii* as a distinct species, *A. Hoehnei* has to be considered endemic to Brazil.

We dedicate this species to Aurelio Schinini, Paraguayan Botanist, at Instituto de Botánica del Nordeste (IBONE), Corrientes, Argentina, who participated in several missions to collect *Arachis* germplasm and herbarium specimens, and first located this species, collecting it on four occasions.

#### 10. *Arachis Gregoryi* C.E. Simpson, Krapov. & Valls *sp. nov.*

Fig. 10

*Ab Arachide magna Krapov., W.C. Greg. & C.E. Simpson, quo maxime affinis, habitu humiliore, foliolis dorsis hirsutis et exocarpio tenui maturitate pluries faticens nigro endocarpio validis nervis praebentibus distinguenda.*

*Holotypus hic designatus:* **BRASIL. Mato Grosso:** Mun. Vila Bela da Santíssima Trindade, Palmarito, 0,8 km ao norte do destacamento militar, na estrada antiga para Vila Bela, em área com vegetação de cerrado junto de campo gramíneo baixo muitas vezes inundado na estação chuvosa, declive suave, 15°29'54"S, 60°13'54"W, 245 m, 26-IV-2004, *J.F.M. Valls & C.E. Simpson 14960* (CEN). *Isotipi:* BRIT, CTES, G, GH, IAC, K, LIL, MO, NCSU, NY, P, PY, RB, SI,SP, TEX, UFMT, US, USZ.

Annual tap-rooted herb, with course stems. Mainstems rounded in fresh specimens but usually angular when dry; 9-45 cm tall (See Obs. I). Internodes 6-28 mm long, with many hairs to 2 mm and many bristles. Mainstem leaflets tetrafoliolate, apical pair 33-48 mm long, 12-22 mm wide; basal pair 30-46 mm long, 11-18 mm wide. Leaflets with many very short hairs on top in young tissue; many fine, long hairs to 1.5 mm on margin and bottom of leaflets. Only a few bristles on leaflet margins. Mainstem leaf petiole 22-59 mm long; rachis 6-14 mm long; both with many hairs and bristles. Adnate part of mainstem stipules 10-15 mm long, 2-3 mm

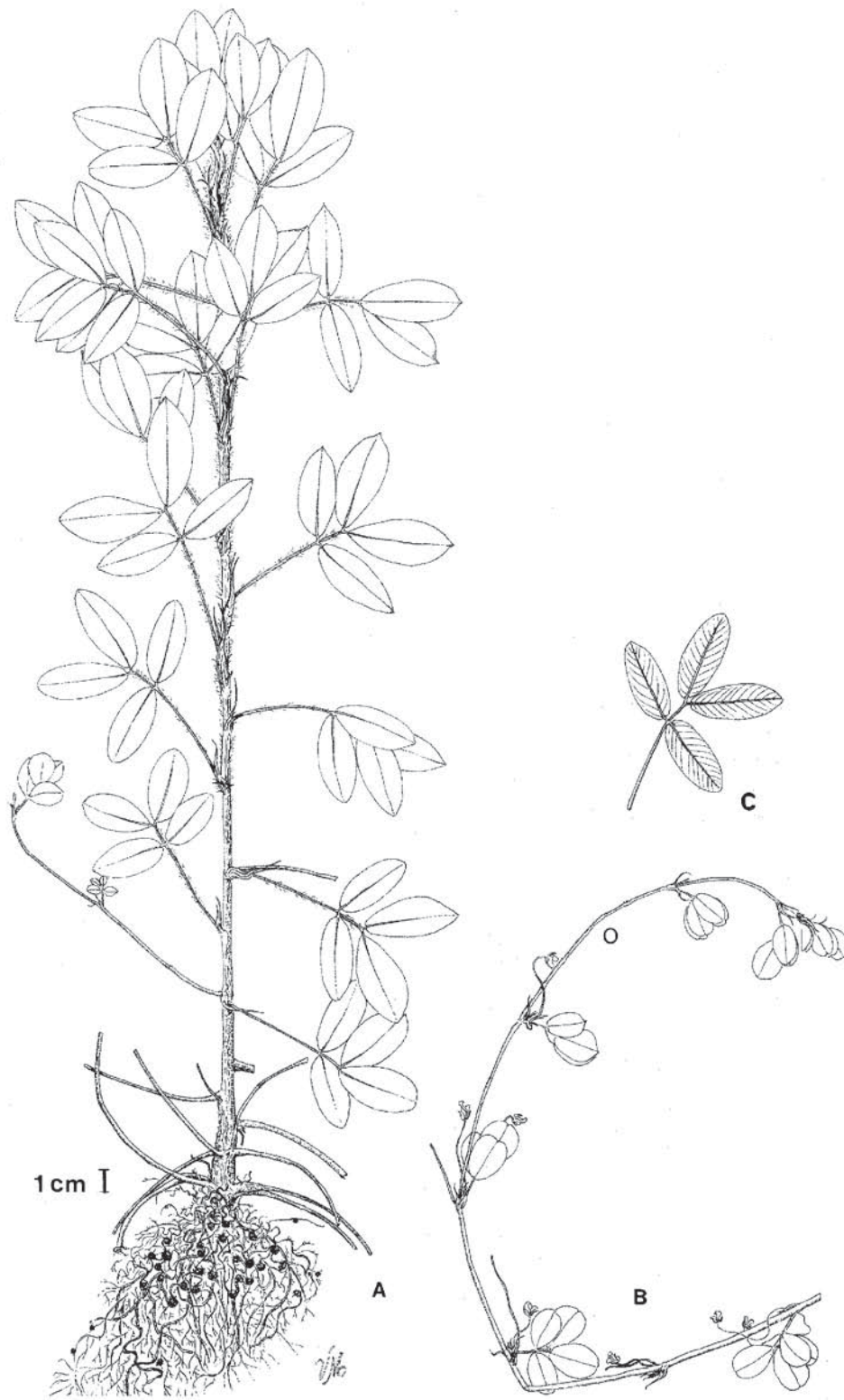


Fig. 10. *Arachis Gregoryi*. A: adult plant, showing long, erect mainstem. B: tip of lateral branch, showing intensive flowering. C: detail of leaf (*Simpson 2940*, cultivated).

wide. Free part of stipule 20-27 mm long, 1-1.5 mm wide. Mainstem stipules also with many coarse hairs on margins, but mostly bristles on outside surface (few hairs). Inside surface of stipules with no bristles or hairs. Few bristles on free part of stipules. Lateral branches round or angular in fresh specimens, angular in dry; 42-124 cm long; internode length 34-77 mm, with many hairs to 1.5 mm and bristles. Lateral branch leaflets elliptic, apical pair 14-18 mm long and 6-13 mm wide; basal pair 9-14 mm long, 5-11 mm wide. Leaflets with many very short hairs on top in young tissue, appearing glabrous in older tissue, with many long, fine hairs to 1.5 mm on bottom. Margins with hairs to 1 mm, with a few scattered bristles. Petioles 3-9 mm long, rachis 2-4 mm long; with both hairs to 1 mm, and bristles. Stipules on lateral branch with hairs to 1 mm, but with many bristles below pulvinus (on adnate part). Few, scattered bristles on free part. Adnate part of stipules 4-7 mm long; free part 6-12 mm long. Hypanthium with numerous fine hairs to 1.5 mm. Calyx bilabiate with many hairs to 1.5 mm, and with bristles. Dorsal portion tetradentate. Standard petal orange, to 9 x 7 mm; wings yellow; to 8 mm, both glabrous. Pegs to 9 cm long, with short hairs on aerial part, but with no bristles. Fruits from 10 x 7 to 17 x 8 mm and mostly smooth with faint veins, but some larger segments with slight to prominent reticulation. The beak is apparent. Fruits losing thin exocarp at maturity to expose black endocarp layer with pronounced veins. Isthmus 12-23 mm long.  $2n=20$  (Peñaloza & Valls, 2005).

*Paratypes*: **BRASIL. Mato Grosso**: Mun. Vila Bela da Santíssima Trindade, Palmarito, approx. 3 km N of Army outpost, 73 km S of Vila Bela, 28-VIII-81, *Valls & al. 6389* (CEN, CTES); aproximadamente 3 km ao norte do destacamento, 26-IV-2004, *Valls & al. 14957* (BRIT, CEN, CTES, G, GH, IAC, K, LIL, MO, NCSU, NY, P, TEX, US); approx. 0.5 km N of Army outpost, 75 km S of Vila Bela, 28-VIII-81, *Valls & al. 6390* (CEN, CTES); aproximadamente 0,6 km ao norte do destacamento, 26-IV-2004, *Valls & al. 14961* (CEN); 400 m a leste da coleta *Valls & al. 14961*, ao longo da estrada antiga para Vila Bela, *Valls &*

*al. 14962* (CEN); id., aproximadamente 72,5 km ao sul de Vila Bela, na estrada nova de Vila Bela para Palmarito, 15°24'18.9"S, 60°12'24.4"W, *Valls & al. 14728* (BRIT, CTES, G, GH, IAC, K, LIL, MO, NCSU, NY, P, PY, RB, SI, SP, TEX, UFMT, US, USZ). **UNITED STATES OF AMERICA. Texas**: Stephenville, 32°14'N, 98°11'W, 400 m, cultivated from seed of *Valls & al. 6389*, 13-VIII-1997, *Simpson 2940* (BRIT, CEN, CTES, K, TEX, US).

Geographic distribution: *Arachis Gregoryi* grows in the white sands of the cerrado vegetation on the border of western Mato Grosso State, Brazil. The species thrives in conditions in the area in which it is probably inundated at least part of the year, during the wet season. The species has only been collected in Brazil, but very likely also grows in Bolivia, because Brazilian collection sites are only 3-5 km from the frontier.

Obs. 1. The new species grows much larger in cultivation. Measurements of herbarium specimens from cultivated plants of *Valls & al. 6389* indicate that these were 50% larger than the plants measured from the type specimen. The cultivated specimens measured were distributed as shown above under the collection number *Simpson 2940*.

Obs. 2. Crosses between *Arachis Gregoryi* and other species gave distinguishing results. Pollen staining percentages of hybrids from the several crosses included: *A. Batizocoi* (accession K 9484), 4.5%; *A. cruziana* Krapov., W.C. Greg. & C.E. Simpson (K 36024), 2.6%; *A. duranensis* (K 7988), 3.2%; *A. glandulifera* Stalker (K 30091), 0.25%; *A. Krapovickasii* (Wi 1291), 12.8%; *A. magna* (K 30097), 13.1%; *A. Schininii* (V 9923), 14.8%; *A. stenosperma* (HLK 410), 6.8%.

We dedicate this species to the memory of Dr. Walton C. Gregory, Professor for many years at North Carolina State University (USA), in recognition of his significant contribution to the knowledge, taxonomic understanding and germplasm resources of the *Arachis* genus.



**11. *Arachis Krapovickasii* C.E. Simpson, D.E. Williams, Valls & I.G. Vargas sp. nov.**

Fig. 11

*Arachidi cruziana* Krapov., W.C. Greg. & C.E. Simpson maxime similis, sed habito multo majore, paxillo manifeste setoso, setis ad foliola marginem plerumque inclinatis et interdum bulbosis differt.

*Holotypus hic designatus:* **BOLIVIA. Santa Cruz:** Prov. Chiquitos, 53 km south of the square at San Jose de Chiquitos at Est. La Fortaleza, on the trail to Tucavaca, 18°14'09"S, 60°51'07"W, 5-VI-1994, D.E. Williams, C.E. Simpson, I.G. Vargas 1291 (CTES). *Isotypi:* BRIT, CEN, G, K, LIL, LPB, MO, NCSU, NY, P, RB, SI, US, USZ.

Annual plants with tap root. Mainstem erect, 20-48 cm high, internode 5-45 mm; green stems rounded, or somewhat angular, not square; angular when dried. Mainstem leaflets elliptical; apical 20-48 mm long, 6-30 mm wide; basal leaflets 13-43 mm long, 5-21 mm wide. Mainstem leaflets with numerous fine hairs to 1 mm on bottom of leaflets, prominent margins with many fine hairs to 1.5 mm and few bristles that are on or near the lower edge of the margin, many of which are pointed down, some with bulbous base. Top of leaflets glabrous. Petioles on mainstem leaves 18-53 mm long, rachis 6-13 mm long. Petioles and rachis with numerous fine hairs to 2 mm and many bristles with 1 mm base. Pulvinus hairy. Stipules on mainstem 11-31 mm total length; adnate part 2-14 mm long and free part 7-20 mm long. Mainstem stipules with hairs to 2 mm on margins, few on outside surface, inside glabrous. Several bristles on adnate part of stipule below pulvinus. Lateral branches procumbent, 40-124 cm long, stems round. Internode length 6-104 mm. Lateral branch stems with many bristles which have a large bulbous base, and many hairs to 1.5 mm. Apical leaflets ovate, 17-28 mm long, 11-19 mm wide; basal leaflets elliptical, 12-27 mm long, 8-15 mm wide. Leaflets on lateral branches with scattered fine hairs on lower surface to 1 mm, with many fine hairs on mid-vein and margins to 1.5 mm and bristles which are on the lower

part of the prominent margin, or just inside the margin, many of these bristles are pointed downward. Upper surface of leaflets glabrous. Stipules on lateral branch leaves 13-21 mm total length, 3-7 mm wide. Adnate part 3-8 mm long and free part 7-14 mm long. Stipules with hairs on outside surface and margins, also with bristles. Inside surface glabrous. Hypanthium with many hairs to 2 mm, also calyx with many hairs to 1 mm. Back of calyx tridentate and also with bristles. Standard orange and wings yellow. Standard to 17 x 14 mm; wings to 10 mm long. Pegs 24-88 mm long. Pegs with profuse hairs on aerial part. Some bristles on the pegs. Fruits large and smooth, with some veins apparent, but no, or very slight, reticulation. The fruits appear more cylindrical than elongated. Beak is very apparent. Fruit segments to 17.9 x 10.6 mm. 2n=20 (Peñaloza & Valls, 2005).

*Paratypes:* **BOLIVIA. Santa Cruz:** Prov. Chiquitos, 38 km S San Jose, in white sand, 18°07'08"S, 60°50'13"W, 325 m, 4-VI-1994. D.E. Williams & al. 1287 (BRIT, CEN, CTES, K, MO, NY, US); 43.9 km S San Jose, growing in white sand, 18°09'13"S, 60°50'20"W, 345 m, 4-VI-1994, D.E. Williams & al. 1288 (BRIT, CEN, CTES, K, NY, MO, US). **UNITED STATES OF AMERICA. Texas:** Stephenville, 32°14'N, 98°11'W, 400 m, cultivated from the original seed collected from the type specimen D.E. Williams & al. 1291, 3-VIII-1997, Simpson 2937 (BRIT, CEN, CTES, K, TEX, NY, US). **BRASIL. Distrito Federal:** Brasília. Cultivada em vasos em telado da Embrapa Cenargen, a partir de sementes do acesso D.E. Williams & al. 1291, 30-VI-1999, Valls 14318 (CEN); id. 2-V-2005, Valls 15120 (CEN).

Geographic distribution: *Arachis Krapovickasii* grows in the white friable sands south of the Chiquitos mountain range and east of Bañados del Izozog, in the area south of San Jose de Chiquitos, Bolivia. In two cases we collected this B genome species growing sympatrically with the A genome species, *A. Cardenasii* Krapov. & W.C. Greg., i.e., D.E. Williams & al. 1286 and 1287, D.E. Williams & al. 1290 and 1291.

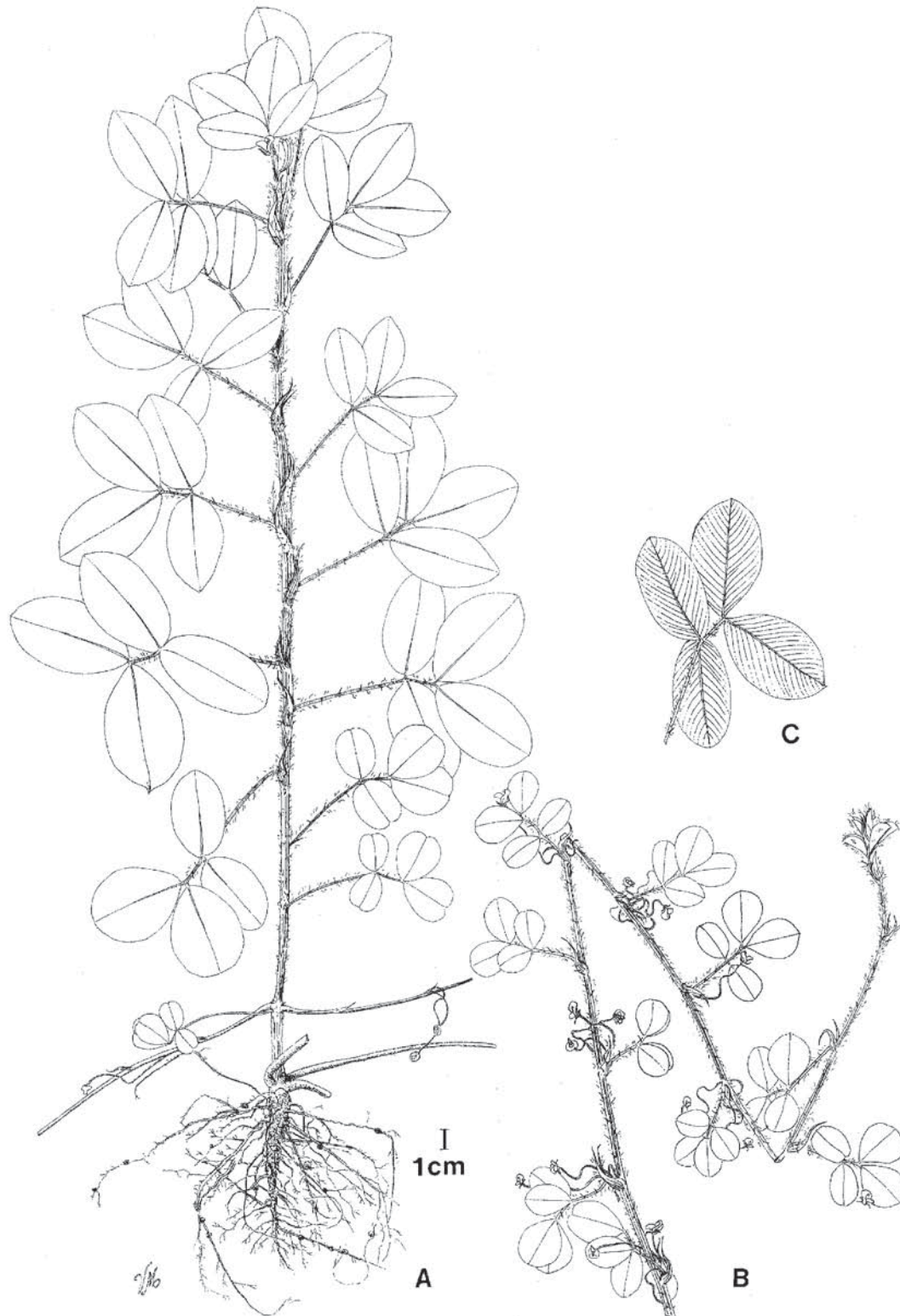


Fig. 11. *Arachis Krapovickasii*. A: adult plant, showing tall, erect mainstem. B: tip of lateral branch, showing intensive flowering. C: detail of lower leaf surface (*Simpson 2937*, cultivated).

Obs. 1. Using measurements based on the fifteen original specimens (*D.E. Williams & al. 1291*) it is difficult to distinguish *Arachis Krapovickasii* from *A. cruziana* and *A. Batizocoi*. The downward angled leaf margin bristles and bristles on the pegs are the most significant distinguishing morphological characters.

Obs. 2. Some specimens of the accessions of this species do not have bristles on any plant part. In these specimens, the hairs are usually more abundant and approximately 1 mm longer than hairs on specimens with bristles.

Obs. 3. Measurements of the cultivated specimens compared to those shown in this description reveal that, on average, the cultivated plants were more than 95% larger than the plants from the type local.

Obs. 4. A limited number of crosses between *Arachis Krapovickasii* and other species resulted in hybrid plants with the pollen stain percentage shown: *A. Batizocoi* (K 9484), 40%; *A. cruziana* (K 36024), 51.2%; *A. Cardenasii* (Wi 1286), 3.3%, *A. Gregoryi* (V 6389), 12.8%; and *A. ipaënsis* Krapov. & W.C. Greg. (K 30076) 1.8%.

We dedicate this species to Ing. Agr. Prof. Antonio Krapovickas, long time Professor of Genetics and Director of Instituto de Botânica del Nordeste (IBONE), Corrientes, Argentina. Prof. Krapovickas has been a central figure in the taxonomy of *Arachis* since the early 1950's, and he continues to be one of the most significant researchers in contributing to the knowledge and understanding of the genus.

### Aknowledgements

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2. *Arachis submarginata* Valls, Krapov. & C.E. Simpson Simpson, C.E. 2718 (5), 2937 (11), 2940 (10).
3. *Arachis Pflugeae* C.E. Simpson, Krapov. & Valls Valls, J.F.M., C.E. Simpson & A. Gripp 6389 (10), 6390 (10).
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